

IN THE SPECIFICATION:

Please amend paragraph [0007] as follows:

[0007] U.S. ~~patent application Serial No. 08/590,919 filed January 24, 1996 by one of the present inventors,~~ Patent 5,937,270 to Canella (“the ‘270 Patent”), assigned to the assignee of the present invention and hereby incorporated herein by this reference, discloses yet another laser marking system which is operable at high throughput volumes and makes substantially constant use of a marking laser by use of a ~~multi-track~~ multi-track IC feed, marking and inspection procedure. While highly successful, the laser marking system of the ~~‘919 application~~ ‘270 Patent feeds singulated, packaged ICs from tubular magazines along two parallel, inclined tracks to a marking zone, after which the marked devices are then automatically inspected and either discarded or re-loaded into other tubular magazines at the output ends of the tracks.

Please amend paragraph [0008] as follows:

[0008] Recently developed IC packages, however, are now much-reduced in size, thickness and dimensions of individual features, such as leads for external connection to ~~higher-level~~ higher-level packaging. One example of such state-of-the-art IC packages is a thin plastic package configuration identified as a Thin Small Outline Package, or TSOP. Another is a Thin Quad Flat Pack, or TQFP. By way of comparison, such packages are dimensioned with a total package thickness, excluding lead fingers, of less than about one-half the thickness of a conventional plastic Small Outline J-lead package, or SOJ, such as would be marked in the above-described system of the ~~‘919 application~~ ‘270 Patent. These newer IC packages, with their smaller dimensions and more fragile components, are much more susceptible to inadvertent damage in handling than prior package designs and, at best, are only marginally robust enough for handling in tubular magazines and by singulated feed-through processing equipment. As a result, the industry has gravitated to processing such relatively delicate IC packages in batches carried in recesses of rectangular trays, one example of which is so-called JEDEC trays. Other, even smaller IC packages under current development and most recently introduced to the market include ~~so-called~~ so-called “chip scale” IC packages. These packages, having dimensions approximating

those of a bare IC die itself and employing extremely minute external connection elements, also are desirably handled in trays. It is contemplated that such chip scale packages may be desirably laser marked on the bare, or thinly coated, backside of the die itself in instances where packaging is largely intended to protect and seal the active surface at the die sides and primarily extends over the sides and active (front) surface of the die. Accordingly, as used herein, the terms “IC-package”, “package,” “packaged IC” or “IC” include not only conventional polymer-encapsulated dice but any dice incorporating sufficient structure to effect operative connection to a higher level package such as a circuit card, or to another die.

Please amend paragraph [0009] as follows:

[0009] In addition to the aforementioned difficulties with marking thin, ~~reduced-dimension~~ reduced-dimension IC packages using tubular magazines and inclined tracks, feeding and marking singulated IC packages, even when grouped for marking, are time-consuming and fraught with potential for workpiece jamming somewhere on the tracks. Further, such an approach requires numerous sensors to verify passage of individual IC packages, location of individual IC packages for marking and inspection, and counting of IC packages to ensure full output magazines, but not magazine overfilling and jamming of the handling equipment for same. Further, movable stops are required to locate and release the IC packages at numerous locations and so, along with the proliferation of sensors, necessitate a somewhat complex and relatively expensive control apparatus for reliable system operation.

Please amend paragraph [0032] as follows:

[0032] FIGS. ~~17A-D~~ 17A-17D are schematic representations of tray input cycle positions of a wedge-type lift mechanism according to one embodiment of the invention; and

Please amend paragraph [0033] as follows:

[0033] FIGS. ~~18A-D~~ 18A-18D are schematic representations of tray output cycle positions of a wedge-type lift mechanism according to one embodiment of the present invention.

Please amend paragraph [0035] as follows:

[0035] A plurality of vertically stacked trays 200 is depicted at both input shuttle assembly 12 and output shuttle assembly 14, the structure and operation of each shuttle assembly being described in more detail below. Also depicted (see FIG. 2) is tray carrier 22, on which a singulated tray 200 carrying a plurality of packaged ICs 202 (also referred to as IC packages) in a rectangular array of recesses 204 (only some shown for clarity) comprising rows and columns may be moved on a tray transport 24 (see FIGS. ~~4-8~~ 4-6) of transport actuator 16 from input shuttle assembly 12 to output shuttle assembly 14. Tray transport 24 may be precisely rotationally aligned with the longitudinal path defined by transport actuator 16 using Allen-type T-nuts, which secure tray transport 24 to the carriage of transport actuator 16.

Please amend paragraph [0036] as follows:

[0036] A downwardly aimed inspection camera 30 as shown on the upstream side of laser marking station 18 may be employed to verify pin one location and thus proper orientation for the packaged ICs 202 in a tray 200 passing thereunder on tray carrier 22, as well as part in tray verification to ensure that each tray 200 is fully loaded with packaged ICs 202 for marking. A similar camera 30 on the downstream side of laser marking station 18 may be employed to verify the presence of laser markings on each packaged IC 202 of a tray 200 which has been processed in laser marking station 18. A tray 200 is preferably stopped twice (and moved a ~~half-tray~~ half-tray length between stops) under downstream camera 30 for mark inspection, as packaged ICs 202 in each longitudinal half of each tray 200 are substantially concurrently marked in a separate laser field by a different, separately (different circuit) controlled laser head of laser marking station 18. Most preferably, marking of the last IC package in each field is checked on the logical premise that satisfactory marking of the last package would not take place if any failure in the laser or beam control circuitry had previously occurred. This sampling approach to inspection achieves the required quality assurance for the marking process with a substantial time savings over inspecting every marked IC package. High-intensity lights (not shown) may be provided at the two camera locations to facilitate inspection.

Please amend paragraph [0038] as follows:

[0038] Input shuttle assembly 12 and output shuttle assembly 14 as depicted in FIGS. 1 and 2 are substantially identical. FIG. 3 shows an enlargement of the portion of FIG. 2 depicting input shuttle assembly 12, and with transport actuator 16 removed for clarity. Input shuttle assembly 12 includes a frame 40 comprising four frame members 42a-d, each having a vertically extending notch 44 facing a rectangular tray stack volume 46 shown in broken lines. Frame members 42a and 42b extend upwardly a greater distance than frame members 42c and 42d, and define the uppermost preferred vertical height limit for a stack of trays 200, two of which trays 200 being shown. As can readily be seen in FIG. 3, a distance or depth from a corner of tray stack volume 46 defined by a notch 44 to a laterally inward edge of each of frame members 42a and 42c is smaller than a distance or depth from a corner of tray stack volume 46 defined by a notch 44 to a laterally inward edge of each of frame members 42b and 42d. Further, there is a laterally extending gap 43 between frame members 42a and 42b and a like-sized gap 43 between frame members 42c and 42d. Protrusions 201 at each end of trays 200 are sized and located on each end of the trays 200 to lie within gaps 43 when a tray 200 is located in tray stack volume 46 so that the input shuttle assembly 12 is “keyed” to only accept trays 200 in the proper rotational orientation. In other words, the frame will not accept a tray 200 placed “backward” in tray stack volume 46. Thus, the packaged ICs 202 in each tray 200 will be in a proper orientation for marking. Each frame member 42a-d supports a tray support element actuator 47 on a ~~height-adjustable~~ height-adjustable bracket 48. Tray support element actuators 47 preferably comprise air (pneumatic) cylinders which, when actuated, retract a tab-like tray support element 50 which is otherwise spring-biased inwardly to intersect a boundary of tray stack volume 46, the tray support elements 50 each being located in their extended positions to enter one of four downwardly facing notches 206 in the side 208 of a tray 200 proximate a tray corner 210. Thus, one or more trays 200 may be supported at four locations within tray stack volume 46. Further, if air pressure to tray support element actuators 47 is lost, any trays 200 within tray stack volume 46 above tray support elements 50 are kept from falling. Tray support element actuators 47 may comprise Myotoku Ltd. TKY-H-8X4 air cylinders. Tray carrier 22 is depicted under tray stack volume 46 in FIG. 3 in position to receive a tray 200 lowered thereon. FIGS. 4-6 depict a tray

unload sequence, wherein (FIG. 4) a tray transport 24 bearing a tray carrier 22 is located initially under tray stack volume 46 of input shuttle assembly 12 out of contact with lowermost tray 200, and parallel side plates 80 of a lift structure 78 (FIG. 5) of a wedge-type lift mechanism 60 as described below are vertically extended through elongated side notches 132 (see also FIG. 3) of tray carrier 22 to supportingly engage the bottom of lowermost tray 200 and support all of the trays in tray stack volume 46. At this point, tray support element actuators 47 are initiated to withdraw tray support elements 50. In FIG. 5, lowermost tray 200 has been lowered on side plates 80 of lift structure 78 a vertical distance (for example, 0.25 inch) equal to the thickness of each tray 200, tray support element actuators 47 deactivated to extend tray support elements 50 into downwardly facing notches 206 of the next highest tray 200, and then lowermost tray 200 further lowered onto tray carrier 22. Tray carrier 22 carrying lowermost tray 200 is then moved horizontally out from under tray stack volume 46 on tray carrier 22 and tray transport 24 as shown in FIG. 6 and toward laser marking station 18.

Please amend paragraph [0039] as follows:

[0039] In unloading trays 200 from tray carrier 22 at output shuttle assembly 14 after passage through laser marking station 18, side plates 80 of a lift structure 78 of a wedge-type lift mechanism 60 are vertically extended through elongated side notches 132 of a tray carrier 22 aligned with the tray stack volume 46 of output shuttle assembly 14 and carrying a tray 200 of marked packaged ICs 202 to raise that tray 200 into supporting contact with a lowermost (or only) tray 200 already in tray stack volume 46 and supported by tray support elements 50 of output shuttle assembly 14. Tray support element actuators 47 are then initiated to retract tray support elements 50, the stack of trays 200 lifted the thickness of one tray 200 (again, for example, 0.25 inch), and tray support element actuators 47 are deactivated to extend tray support elements 50 into downwardly facing notches 206 of the lowermost tray 200 just lifted from tray carrier 22 and support the stack of trays 200. Of course, if there are no trays at output shuttle assembly 14 when a tray carrier 22 bearing a tray 200 arrives, the sequence will be the same. After side plates 80 are vertically withdrawn below the level of tray carrier 22 on tray

transport 24, tray carrier 22 is returned on tray transport 24 to input shuttle assembly 12 to receive another tray 200 of unmarked packaged ICs 202.

Please amend paragraph [0040] as follows:

[0040] A significant feature of the laser marking system 10 is a particular wedge-type lift mechanism 60 (located as noted by reference numerals 20 on the previously referenced drawing figures) as depicted in various positions in FIGS. 7-9. In the preferred embodiment, lift mechanism 60 is employed with input shuttle assembly 12, output shuttle assembly 14 and laser marking station 18. Lift mechanism 60 includes a horizontally oriented stop dual-action (i.e., positive bidirectional actuation) air cylinder 62, which may comprise a Parker Series S pneumatic cylinder. Shaft 64 of cylinder 62 is extendable and retractable under air pressure to selectively provide a stop for dual-action, pneumatically actuated drive block 66 riding on dual parallel horizontal guide shafts 68. Drive wedge element 70 carried on drive block 66 and secured thereto has an upper inclined surface 72 upon which is supported lower inclined surface 74 of slave wedge element 76. Slave wedge element 76 is constrained against horizontal movement by attachment to a three-sided lift structure 78 comprising vertically extending side plates 80 and horizontal floor 82, side plates 80 being contained and guided by linear bearings 86 so as to permit only vertical movement. As drive block 66 moves horizontally, such movement is translated into vertical movement of the lift structure 78 by movement of the inclined upper surface 72 of drive wedge element 70 against lower inclined surface 74 of slave wedge element 76. Due to the angle of inclination of surfaces 72 and 74, horizontal motion results in reduced vertical motion (by, for example, a 4:1 horizontal to vertical ratio) but increased force over the smaller vertical distance as well as a smoother vertical movement of lift structure 78, reducing any shock of contact of lift structure 78 with a tray 200. Furthermore, the control system for the lift mechanism 60, since it involves control of only two dual-action air cylinders, is extremely simple compared to conventional stepper or servo controls. In the preferred embodiment, the wedge-type lift mechanism 60 with air cylinder 62 and drive block 66 may be manipulated to move in a vertical increment equal to the thickness of trays 200, as alluded to above. Such manipulation is possible due to the difference in travel between shaft 64 of air

cylinder 62, which may be either three inches or one inch in the disclosed embodiment as explained below, and drive block 66, which is four inches in the disclosed embodiment. Further, air cylinder 62 is sized to generate substantially more force than drive block 66, so that actuation of air cylinder 62 in opposition to drive block 66 precludes further movement of drive block 66 upon contact with shaft 64. Stated alternatively, the shaft 64 of air cylinder 62 may be selectively extended to act as a stop to full horizontal travel of drive block 66 and thus provide lift mechanism 60 with a vertical position between fully extended and fully retracted.

Please amend paragraph [0041] as follows:

[0041] The uppermost vertical position of lift structure 78 of the lift mechanism 60 may obviously be designed in light of the level to which a tray 200 must be lifted. For example, when used with both input shuttle assembly 12 and output shuttle assembly 14, the uppermost vertical position of lift structure 78 (in this instance, 1.00 inch elevation) would be in supporting contact with the lowermost tray 200 in tray stack volume 46. When used with input shuttle assembly 12, the uppermost vertical position is used to supportingly engage the lowermost tray 200 in tray stack volume 46 and support it to permit retraction of tray support elements 50. When used with output shuttle assembly 14, the uppermost vertical position of lift structure 78 would be the same (1.00 inch) as for input shuttle assembly 12, that is, one tray thickness (i.e., 0.25 inch) higher than the bottom of the lowermost tray 200 in the tray stack volume, so that a tray 200 full of marked IC packages 202 may be raised into lifting contact with the lowermost tray 200 of a stack (or, stated another way, so that notches 206 of the tray 200 being lifted by the lift structure 78 are above the tray support elements 50) so that the tray 200 being lifted from the tray carrier 22 (and trays 200 thereabove in the stack) may be supported by extended tray support elements 50. Thus, tray transport 24 with tray carrier 22 may be returned to input shuttle assembly 12 to receive another tray 200. When used with laser marking station 18, the uppermost vertical position of lift structure 78 is also the same (1.00 inch) and is employed to place a tray 200 on tray carrier 22 within a substantially bottomless, laser light safe enclosure, as will be described in more detail below.

Please amend paragraph [0042] as follows:

[0042] As shown in FIGS. 7-9 with specific reference to a lift mechanism for an input shuttle assembly 12, lift mechanism 60 as described may be programmed to one of several vertical positions over a total travel of 1.00 inch, including a zero elevation position wherein lift structure 78 is completely retracted out of contact with a tray 200 when the latter rests on tray carrier 22 on tray transport 24 carried by transport actuator 16. For example, and with specific reference to FIG. 7, the lowermost vertical position of lift mechanism 60 (and therefore of lift structure 78) is achieved when air cylinder 62 is actuated to withdraw shaft 64 to the left as shown in the drawing figure, while drive block 66 is similarly moved to the left so that slave wedge element 76 is substantially superimposed over drive wedge element 70. In order to raise lift structure 78 to its uppermost vertical position as shown in FIG. 8 to, for example, receive a tray 200 from input shuttle assembly 12, drive block 66 is actuated to move its full horizontal travel (four inches) to the right, yielding 1.00 inch of lift travel. At the same time, or subsequently, air cylinder 62 may be actuated to drive shaft 64 its full horizontal travel (three inches) to the right in preparation for the next movement sequence of lift mechanism 60. After tray 200 at the bottom of a tray stack in input shuttle assembly 12 is contacted by side plates 80 of lift structure 78 and tray support elements 50 retracted as previously described, drive block 66 is positively actuated to move to the left. However, contact with extended shaft 64 of air cylinder 62 as shown in FIG. 9 prevents further, leftward movement of drive block 66, resulting in a downward vertical movement of lift structure 78 of only 0.25 inch (one inch of horizontal travel of drive block 66 being reduced by a 1 to 4 ratio due to the angle of inclination of ~~like-angled~~ like-angled inclined surfaces 72 and 74) to a 0.75 inch elevation. At this point, tray support elements 50 are again extended to support the next-lowermost tray 200 in the stack as shown in FIG. 5, and air cylinder 62 may then be actuated to positively drive shaft 64 to the left, followed by leftward movement of already-actuated drive block 66 to return lift structure 78 to its lowermost position as shown in FIG. 7. A complete tray input cycle sequence of positions of drive wedge element 70, slave wedge element 76, shaft 64 and drive block 66 of a wedge-type lift mechanism 60 usable with an input shuttle assembly 12 according to one embodiment of the present invention is schematically depicted in FIGS. 17A-17D. Lift mechanism 60 moves from

its lowermost position (FIG. 17A) to its uppermost elevation of 1.00 inch (FIG. 17B), moves downward 0.25 inch to a 0.75 inch elevation (FIG. 17C) and then moves back to its lowermost position (FIG. 17D). It should be noted that, while the elements of wedge-type lift mechanism 60 are the same when used with both input shuttle assembly 12 and output shuttle assembly 14, air cylinder 62 is reversed in orientation due to space considerations and the travel of shaft 64 extending therefrom is abbreviated, as explained further below.

Please amend paragraph [0043] as follows:

[0043] When lift mechanism 60 is employed with output shuttle assembly 14, the initial raised position of lift structure 78 is at 0.75 inch, wherein the bottom of a stack of trays 200 is contacted in supporting relationship by a tray 200 of marked IC packages 202. Then, tray support elements 50 are retracted to permit lift structure 78 movement to full vertical travel of 1.00 inch to lift the tray stack upwardly one tray thickness so that tray support elements 50 may be extended to support the stack by the newly added lowermost tray 200 just received from tray carrier 22. A complete tray output cycle sequence of positions of drive wedge element 70, slave wedge element 76, ~~shaft 64~~ shaft 64' and drive block 66 of a wedge-type lift mechanism 60 usable with an output shuttle assembly 14 according to one embodiment of the present invention is schematically depicted in FIGS. 18A-18D. As depicted in FIGS. 18A-18D, when used with an output shuttle assembly 14, the lift mechanism 60 moves from a lowermost position (FIG. 18A) to a 0.75 inch elevation position (FIG. 18B), wherein drive block 66 has moved from left to right, but its travel has been halted by contact with extended shaft 64' of air cylinder 62, in this instance, placed to the right of drive block 66 rather than to the left. Since shaft 64', when extended, only travels one inch, the travel of drive block 66 to the right is halted at the 0.75 inch elevation of lift mechanism 60. Shaft 64' is then retracted to the right, followed by drive block 66, causing lift mechanism 60 to reach its full vertical travel of 1.00 inch (FIG. 18C). Drive block 66 is then moved to the left (FIG. 18D).

Please amend paragraph [0044] as follows:

[0044] It may be desirable to include sensors in lift mechanism 60 to detect positions of drive block 66 and shaft 64 or 64'. For example, drive-~~block~~ block 66 position may be sensed using magnetic proximity sensors, while the extension or retraction of shaft 64 or 64' may be inductively sensed. Other types of sensors, for example, optical sensors or contact switches, might also be employed in this capacity.

Please amend paragraph [0045] as follows:

[0045] In use with laser marking station 18, only drive block 66 is required in lift mechanism 60, since only two vertical positions are required. The first position of lift structure 78 corresponds to that shown in FIG. 7, while the second, full vertical extension position of lift structure 78 corresponds to that shown in FIG. 8. The second position extends a tray carrier 22 bearing a tray 200 into enclosure 120 (FIGS. 1, 2, 15-~~& 16~~) and 16) of laser marking station 18 as will be more fully described below.

Please amend paragraph [0047] as follows:

[0047] Referring to FIG. 12 of the drawings, the reader will note the presence of an additional hemispherical recess 98 on lower surface 90 of tray carrier 22 offset from the ~~four~~ other hemispherical recesses 92. Additional recess 98, when used with a longitudinally foreshortened (in comparison to tray carrier 22) tray transport 24 as shown in FIGS. 11-14, permits the tilting of a tray 200 on tray carrier 22 (constrained against movement, of course, by corner stops 100 extending upwardly from substantially planar upper surface 101 of tray carrier 22) by vertical extension of a shaft 102 of an air cylinder (not shown), shaft 102 being surmounted by a bearing cylinder supporting a spherical bearing 104 of like radius to bearings 94 and aligned with additional recess ~~98~~ 98. The two recesses 92 most distant from, and diagonally located with respect to, additional recess 98, engaged by their cooperating bearings 94 of tray transport 24, provide a tilt pivot point or fulcrum for tilting of tray carrier 22 and the tray 200 residing therein at an angle to the longitudinal axis of the normally superimposed tray carrier 22 and tray transport 24, such tilting being further facilitated by diagonal truncation or

cutout 106 of the nearby corner of tray transport 24. Tilting results in movement of each IC package 202 in a tray borne by the tray carrier 22 toward the same corner of the tray recess 204 (FIG. 2) in which that IC package 202 is located. Also noteworthy in FIGS. 13 and 14 is the presence of part movement facilitator 110, which may comprise a vibrator, or an air cylinder actuated to "tap" the tray carrier 22 repeatedly to overcome any sliding friction preventing the IC packages 202 from moving to their desired positions. The tray tilting location (with optional part movement facilitator 110) may be at the position of tray transport 24 under the laser marking station 18 to effect precise alignment of IC packages 202 immediately before marking or may be located at the upstream side of laser marking station 18 where tray carrier 22 passes under inspection camera 30, so that the position of each IC package 202 may be checked.

Please amend paragraph [0048] as follows:

[0048] Yet another significant feature of the laser marking ~~system~~ system 10 of the present invention is the configuration of laser marking station 18. Specifically, laser marking station 18 employs a substantially bottomless enclosure 120 having four sides and a roof (see FIGS. 1, ~~2, 15~~ 2, 15, and 16) which, unlike conventional marking stations previously referenced herein, does not require opening and closing of access shutters to admit a group of IC packages to be marked. Instead, a tray 200 of unmarked IC packages 202 positioned below enclosure 120 as shown in FIG. 15 and residing on carrier tray 22, which in turn rests on tray transport 24 of transport actuator 16 (not shown in FIGS. 15 and 16 for clarity), may be raised off of tray transport 24 into the opening 122 defined in the bottom of enclosure 120 when contacted by parallel extensions 124 at the tops of side plates 80 of lift structure 78, the upper ends 126 of extensions 124 including notched edges 128 bracketing a central protrusion 130 sized and located to closely fit within elongated side notches 132 of tray carrier 22. As shown in FIGS. ~~10-14~~, 10-14, the lateral extent or width of tray transport 24 is less than that of tray carrier 22 so that side plates 80 pass outboard of tray transport 24 before extensions 124 engage elongated side notches 132 of tray carrier 22. As shown in FIG. 16, when lift structure 78 of lift mechanism 60 is fully vertically extended, tray carrier 22 is substantially contained within enclosure 120 and the tray 200 is located completely within enclosure 120 at the proper focal length for laser marking

with the assurance that laser light emitted from the marking heads will be completely contained within enclosure 120. Further, tray carrier 22 is sized and shaped to act as a substantially light-tight closure to bottom opening 122 of enclosure 120. Completion of the closure is effected by the presence of extensions 124 in elongated side notches 132, extensions 124 being of adequate width to fill the width of notches 132. Assurance of a light-tight enclosure 120 may be further provided with magnetic sensors on the interior of enclosure 120 which will confirm the proper location of tray carrier 22 in position responsive to the presence in the proper location within enclosure 120 of two magnets 134 (FIGS. 10, 11, 13-~~& 14~~) and 14) secured in tray carrier 22.